DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
1322 PATTERSON AVENUE, SE SUITE 1000
WASHINGTON NAVY YARD DC 20374-5065

2 September 2010

From: Commander, Naval Facilities Engineering Command

Subj: INTERIM TECHNICAL GUIDANCE (ITG 2010-03) - APPLICATION OF SOLID STATE LIGHTING (SSL)/LIGHT EMITTING DIODE (LED) FOR EXTERIOR LIGHTING

Ref: (a) Energy Policy Act (EPAct) of 2005 (Public Law 109-58), dated 8 August 2005
(b) Executive Order 13423: Strengthening Federal Environmental, Energy and Transportation Management, dated 24 January 2007
(c) Assistant Secretary of the Navy (Installations and Environment) Memorandum: Energy and Utilities Development in MCON and Special Projects, dated 4 August 2006
(d) UFC 3-530-01 Design: Interior and Exterior Lighting and Controls available at http://www.wbdg.org/ccb/DOD/UFC/ufc_3_530_01.pdf
(e) UFGS 26 56 00 Exterior Lighting available at http://www.wbdg.org/ccb/DOD/UFGS/UFGS%2026%2056%2000.pdf

Encl: (1) Point Paper titled "Potential benefits of induction and solid state lighting (SSL)/Light emitting diode (LED) for exterior lighting"
(2) LED Technology - Technical Specification Information

1. Purpose. This ITG provides the basic criteria guidance concerning the implementation and design of solid state lighting (SSL)/light emitting diode (LED) technologies for exterior lighting applications such as area and street lighting.

2. Background. The majority of exterior lighting on DoD installations is high pressure sodium (HPS). HPS systems have been in place for many years, are inefficient when compared to today's standards, and have not been maintained to industry standards.

Per reference (d), the only broad spectrum lighting source approved for exterior lighting is induction (electrodeless fluorescent). Induction lighting was introduced to the market over fifteen years ago, is a proven technology, and has been in UFC 3-530-01 since 2005. References (d) & (e) are currently under revision to include LED technology for exterior lighting systems.

Subj: INTERIM TECHNICAL GUIDANCE (ITG 2010-03) - APPLICATION OF SOLID STATE LIGHTING (SSL)/LIGHT EMITTING DIODE (LED) FOR EXTERIOR LIGHTING

3. Discussion. With the dissemination of references (a), (b) & (c), there has been a great deal of interest in utilizing energy efficient lighting systems to help reduce energy consumption.

LED is a broad spectrum light source which has the potential to provide a 50-60% reduction in energy consumption, while greatly reduce maintenance costs. Department of Energy Study indicates the possibility of 80-90% savings in maintenance costs over traditional high intensity discharge (metal halide & HPS) systems.

LED technology allows better control of the light distribution, reduces "hot spots", and results in a visible improvement in uniformity.

Broad spectrum lighting increases color rendering by 300% over traditional HPS lighting sources. LED are instant on, dimmable, and advertise lamp life of 50,000+ hours. The 50,000 hour lamp life for LED relates to a 30% reduction of lumen output, not actual lamp failure. Lamp life for HPS is 20,000 hours, but is defined as hours to 50% lamp failure. To maintain 70% lumen output, a high pressure sodium lamp would have to be replaced every two years. An LED with a 50,000 hour lamp life would have to be replaced in 11 years.

Current LED product quality can vary significantly among manufacturers so diligence is required in the selection and application. Actual lamp life of LED luminaires (fixtures) varies with luminaire design (heat dissipation) and ambient temperature. Improper application or poor luminaire design can lead to rapid lumen depreciation and premature failure and because of their incredibly long life span; a poorly chosen SSL-LED system could plague an end user for years.

4. Action. Solid State Lighting (SSL)/Light Emitting Diode (LED) lighting systems are approved for exterior applications such as area and street lighting with the following criteria established.

- Utilize Reference (d) for design of all lighting systems. Reference (d) is currently under revision to include LED technology for exterior lighting systems.
- Evaluate each application to determine which broad spectrum technology (induction or LED) suits the application and local environment conditions. LED should not be considered as a "one size fits all" solution.
-

- Design replacement systems to minimize overall energy consumption, reduce maintenance costs, illuminate areas to the appropriate levels, improve uniformity, reduce light trespass/light pollution, and improve the night time visibility on Navy Installations. Simple retrofit projects will only yield minimum benefit.
- Retrofit conversion LED lamps or LED lighting modules that have been designed and constructed to be installed in existing high-intensity discharge (HID), mercury vapor, or fluorescent luminaire enclosures are prohibited.
- Incorporate enclosure (2) into contract documents for all projects utilizing LED technology for exterior lighting.
- Consider implementing control systems such as occupancy sensors or curfew controls into projects to further reduce energy consumption and extend lumen maintenance life.

5. Coordination. This ITG has been coordinated with NAVFAC Electrical Engineering Working Group, NAVFAC EPO, NAVFAC Fire Protection, NAVFAC Safety, NAVFAC ATFP, HQ USMC, and the Tri-Service Electrical Engineering Working Group. ITGs are published by CIENG as part of the NAVFAC Criteria Program and are available in PDF and Microsoft Word format on the WBDG at http://www.wbdg.org/ccb/browse_cat.php?o=30&c=212

6. Point of Contact. For clarification or additional information related to this subject, please contact either Richard Cofer, P.E., DSN 262-4447, Comm. (757) 322-4447, e-mail richard.cofer@navy.mil or John Peltz, P.E. DSN 262-4208, Comm. (757) 322-4208, e-mail john.peltz@navy.mil

R. J. COFER
By direction

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Copy to:
CMC Washington
HQ USMC (LLF)

Richard Cofer
NAVFAC Atlantic, CIENG
2 August 2010

SUBJECT: Potential benefits of induction and solid state (SSL)/Light emitting diode (LED) for exterior lighting

BACKGROUND

The majority of exterior lighting on DoD installations is high pressure sodium (HPS). HPS lighting was originally implemented to replace mercury vapor lights which was more efficient and had a longer lamp life. The poor light quality of HPS was seen as a small factor in comparison to needed cost savings. HPS systems have been in place for many years, are inefficient when compared to today's standards, have a lamp life of approximately 20,000 hours, and have not been maintained to industry standards due to dwindling resources.

There has been a great deal of advancements in lighting technology and the understanding of how uniformity, glare, and broad spectrum lighting (white light) affects nighttime visibility. UFC 3-530-01 Interior, Exterior Lighting, and Controls was published in 2005 and incorporated the design concepts of uniformity, glare, luminance, and adaptation to improve nighttime visibility. UFC 3-530-01 is currently under revision to incorporate the LED technology. Currently, only induction lighting is approved for exterior lighting.

DISCUSSION

Induction lighting (electrodeless fluorescent) was introduced to the market over fifteen years ago and is a proven technology. In recent years, LED technology has been introduced and has received a lot of attention from the industry. Both induction and LED are broad spectrum light sources which increase color rendering by 300% over traditional HPS lighting sources. Both induction and LED are instant on, dimmable, and advertise lamp life of between 50,000 (LED) and 100,000 (induction) hours. Actual lamp life of LED varies with luminaire design (heat dissipation) and ambient temperatures. Induction lighting efficiency may be degraded in areas with lower ambient temperatures. The City of San Diego has utilized induction lighting in the city's Gas Lamp district for over 12 years without a lamp failure. Department of Energy Study indicates the possibility 80-90% savings in maintenance costs over traditional high intensity discharge systems (metal halide & HPS) systems.

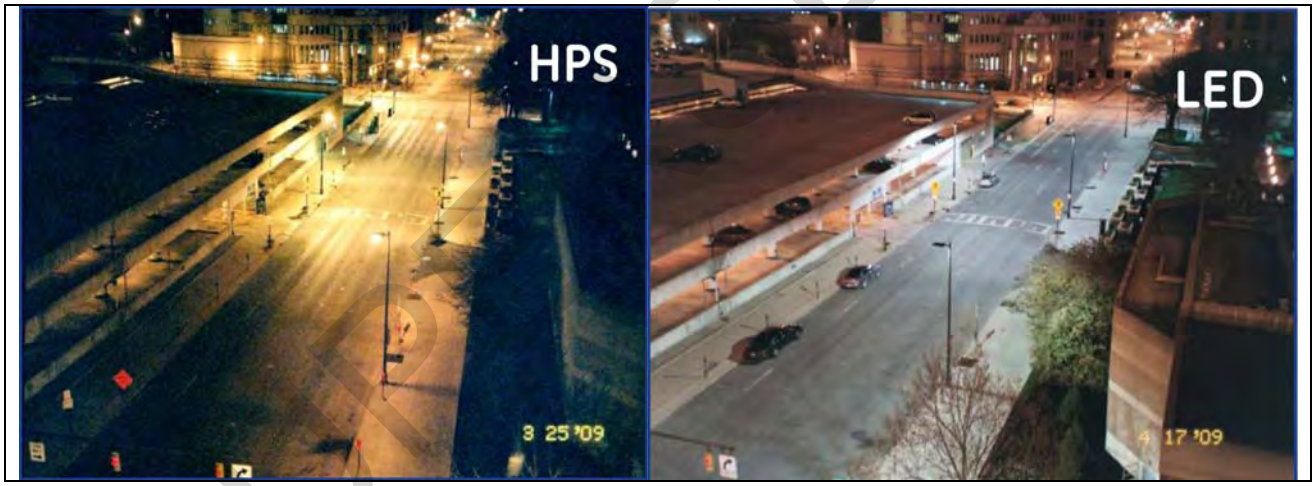
In an effort to reduce energy consumption and maintenance costs several municipalities have conducted exterior lighting studies and retrofit programs using LED and induction (electrodeless fluorescent) technologies.

Results from a number of studies and tests by municipalities across North America have demonstrated that replacing roadway and area lighting is both cost-effective and feasible. These projects save energy, reduce life cycle costs, and improve the nighttime environment. Both LED and induction lighting have been tested and found effective. For example:

- Estimates for the City of Anchorage project to retrofit all streetlights with broad spectrum sources (which can meet a level of performance equal to that of HPS sources with considerably fewer watts per foot of roadway) indicate that payback will be about eight years.
- The city of Calgary has recently replaced most residential street lights with energy efficient models. The motivation is primarily operation cost and environmental conservation. The costs of installation are expected to be regained through energy savings within six to seven years.
- Toronto's officials estimate that replacing its street lights with LEDs will save it $6m a year in electricity costs, and cut CO2 emissions by 18,000 tons annually.
- San Jose plans to convert 100 lights in 2009, and is seeking $20 million from a government stimulus package to install 20,000 new lights. The goal is to have all the city's streetlights changed by 2022, with estimated payback in eight years.

Some paybacks calculation included loan interest rates and no consideration for the reduction in maintenance costs.

In several of these studies, it was determined with detection distance experiments that existing 250 Watt HPS luminaires could be replaced by either 165 watt induction or 160 watt Light Emitting Diode (LED) luminaires. Public surveys were conducted in San Diego and Anchorage and the surveys indicated that the LED and induction light sources provided a much more desirable nighttime environment than HPS.



The Tri-Service Electrical Engineering Working Group is currently working on criteria on the application of induction and LED for exterior lighting.

CONCLUSION

Exterior lighting projects are easy to implement and have both short and long term benefits. Both induction and LED provide a 50-60% reduction in energy consumption and have the potential to greatly reduce maintenance costs. However, there is no a one sized fits all solution when replacing exterior lighting systems.

In areas with lower ambient temperature LED technology may be the best solution and in areas with higher ambient temperatures areas, induction lighting may be the best. Each technology has limitations. For example, there are no LED or induction luminaires that should be used for high mast applications (heights over 40'). Studies have shown that the application does not meet the industry photometric requirements.

Induction and LED and lighting are instant on and dimmable. With proper design, these systems can reduce energy consumption between 50% and 60%, reduce maintenance costs up to 80%, improve uniformity, reduce glare, and increased small target visibility by 50% over comparable HPS systems. When combined with centralized control systems, early studies in Anchorage show energy savings are approaching 75% over the existing HPS system.

A comprehensive plan for replacing exterior lighting on installations will:

- Reduce energy use to comply with mandated goals
- Improve outdoor lighting quality to improve nighttime visibility
- Significantly reduce maintenance costs
- Improve security and safety
- Minimize environmental impact (light trespass/light pollution)

Several approaches can accomplish energy reduction:

- Reduce load and/or wattage with broad spectrum lighting
- Light only to the appropriate level (many areas are over illuminated)
- Dim lighting during seasonally and curfew hours and/or for demand response
- Turn off lights when not required (landscape, decorative, outlying parking areas)
- Reduce equipment quantities

RECOMMENDATIONS

- Do not dictate the technology to be used; neither induction nor LED should be considered as a "one size fits all" solution. Evaluate each application to determine which technology suits the application and local environment.
- Broad Spectrum lighting systems must be designed to realize the full benefit of replacing the existing systems. Simple retrofit projects will only yield minimum benefit.
- Pursue replacement of exterior HPS lighting systems with broad spectrum lighting to reduce overall energy consumption, reduce maintenance costs, and improve security and safety on Installations.
- Pursue lighting replacement projects in conjunction with alternative energy projects to reduce overall load on system.
- Consider implementing control systems into projects to further reduce energy consumption and provide maintenance alerts and data tracking.
- Use UFC 3-530-01, Interior, Exterior Lighting, and Controls for the design of all lighting projects.

LED Technology - Technical Specification Information

Revision: 8/24/10

PART 1 GENERAL

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NOTE to Designer: This document contains technical guidance in the form of "hidden text" enclosed by rows of asterisks. To view this hidden text in "Word", select the "paragraph symbol in Word 2007" or the "show hide button in Word 2003" on the "standard toolbar".

Remove this note, and turn off the hidden text prior to:

- Inserting the project specific "edited "version of this attachment into a project RFP. Verify project RFP also contains requirements that would normally be inserted from Exterior Lighting Specification including pole requirements, wind loading calculations etc.

- Inserting the appropriate portions into a project specific Section 26 56 00 Exterior Lighting. Designer must edit carefully since some of the information within may be more stringent than the normal requirements of UFGS Section 26 56 00.

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NOTE: Instructions for using this Attachment.

With the exception of the first "Note to Designer", text enclosed in asterisks is hidden text that will not print when the "hidden text" box in the "Print/Options" is un-checked.

The electrical designer must edit the bracketed information within this attachment for the requirements of the project.

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1-1 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Publications are referenced within the text by their basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C78.377	(2008) Specifications for the Chromaticity of Solid State Lighting Products
ANSI C136.31	(2001) American National Standard for Roadway Lighting Equipment – Luminaire Vibration

AMERICAN SOCIETY FOR TESTING AND MATERIALS INTERNATIONAL (ASTM)

ASTM B 117	(2009) Standard Practice for Operating Salt Spray (Fog) Apparatus

ASTM G 154 (2006) Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials

FEDERAL COMMUNICATIONS COMMISSION

(FCC) Title 47 SubPart B, Section 15, Class B Emission Limits for Electronic Noise

ILLUMINATING ENGINEERING SOCIETY OF NORTH AMERICA (IESNA)

IESNA HB-9. (2000; Errata 2004; Errata 2005) IES Lighting Handbook

IESNA LM-79 (2008) Approved Method for the Electrical and Photometric Measurements of Solid-Sate Lighting Products

IESNA LM-80 (2008) Approved Method for Measuring Lumen Maintenance of LED Light Sources

IESNA TM-15 (2007; Addendum 2009) Luminaire Classification System for Outdoor Luminaires

IESNA RP-8 (2000; Errata 2004; R 2005) Roadway Lighting

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41.2 (2002) IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

IEEE Std 100 (2000) The Authoritative Dictionary of IEEE Standards Terms

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 60068-2-30 (2009) Environmental Testing – Part 2- Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)

IEC 60068-2-14 (2009) Environmental Testing – Part 2-14: Tests – Test N: Change of Temperature

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 60529 (2004) Degrees of Protection provided by enclosures (IPCode) (IEC 60529)

NEMA C136.3 (2005) Roadway and Area Lighting Equipment Luminaire Attachments

NEMA C136.10	(2006) American National Standard for Roadway Lighting Equipment-Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing
NEMA ICS 6	(1993; R 2006) Standard for Industrial Controls and Systems Enclosures
NEMA WD 7	(2000, R 2005): Occupancy Motion Sensors

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2008; AMD 1 2008) National Electrical Code - 2008 Edition

U.S. ENVIRONMENTAL PROTECTION AGENCY (EPA)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System

UNDERWRITERS LABORATORIES (UL)

UL 1310	(2005, Rev thru Apr 2010) Class 2 Power Units
UL 1598	(2008; Rev thru Jan 2010) Luminaires
UL 773	(1995; Rev thru Mar 2002) Standard for Plug-In Locking Type Photocontrols for Use with Area Lighting
UL 773A	(2006) Nonindustrial Photoelectric Switches for Lighting Control
UL 8750	(2009) UL Standard for Safety for Light Emitting Diode (LED) Equipment for Use in Lighting Products,

1-2 DEFINITIONS

a. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be as defined in IEEE Std 100.

b. Useful Life is the operating hours before reaching 70% of the initial rated lumen output point with no catastrophic failures under normal conditions.

1-3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only or as otherwise designated. When used, a designation following the

"G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Photometric Plan; G

- Submit computer generated photometric analysis of the designed to values for the "end of useful life" of the lighting installation, using an LLD value of 0.7. Submittal shall include the following:
    - Horizontal illuminance measurements at finished grade. Spacing between computer calculation points must be 10'
    - Vertical illuminance measurements at 5 foot above finished grade)
    - Minimum footcandle level
    - Maximum footcandle level
    - Average maintained footcandle level
    - Maximum and minimum ratio (Horizontal)

Warranty; G

SD-02 Shop Drawings

Luminaire drawings; G

SD-03 Product Data

[Energy Efficiency; G]

Luminaires; G

Photocell Switch; G

Timeswitch; G

[Controls; G]

SD-05 Design Data

Design Data for Luminaires; G

Wind Loading Calculations, G

SD-06 Test Reports

IESNA LM-79 Report; G

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NOTE: The following items, some of which are listed as typical in IESNA LM-79, are mandatory with this specification.

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Submit report on manufacturer's standard production model luminaire. LM-79 submittal shall include:

- Testing agency, report number, date, manufacturer's name, catalog number, LED driver, drive current, ambient temperature
- Luminaire Efficacy (Lumens/watt)
- Color Qualities (CCT and CRI)
- Electrical Measurements (input voltage, input current, input power (watts))
- Spectral Distribution over visible wavelengths (mW/nm)

In addition, submittal shall include the following based on the LM-79 testing:

- Picture of sample
- Isocandela Plot
- Luminance Summary table
- Illuminance – Point to Point
- Illuminance – Isofootcandle Plot
- Absolute Intensity Candlepower (cd) Summary table
- Photometric File including B.U.G rating in IES Format

IESNA LM-80 Report; G

Submit report on manufacturer's standard production LED package, array, or module. Submittal shall include:

- Testing agency, report number, date, type of equipment, and LED light source being tested.
- All data required by IESNA LM-80

Test laboratories for the IESNA LM-79 and IESNA LM-80 reports shall be one of the following:

- National Voluntary Laboratory Accreditation Program (NVLAP) accredited for solid-state lighting testing as part of the Energy-Efficient Lighting Products laboratory accreditation program.

- One of the qualified labs listed on the DOE SSL web site (http://www1.eere.energy.gov/buildings/ssl/test_labs.html).

- A manufacturer's in-house lab that meets the following criteria:

a) Manufacturer has been regularly engaged in the design and production of high intensity discharge roadway and area luminaires and the manufacturer's lab has been successfully certifying these fixtures for a minimum of 15 years,

b) Annual equipment calibration including photometer calibration in accordance with National Institute of Standards and Technology.

SD-07 Certificates

Fixture Useful Life Certificate; G

Submit certification from the manufacturer indicating the expected useful life of the luminaires provided. The useful life shall be directly correlated to the IESNA LM-80 test data, adjusted for the thermal properties of manufacturer's luminaire, and adjusted for local average ambient operating conditions.

1-4 QUALITY ASSURANCE

1-4.1 Drawing Requirements

1-4.1.1 Luminaire Drawings

Include dimensions, effective projected area (EPA), accessories, and installation and construction details.

1-4.2 Design Data for Luminaires

a. Distribution data according to IESNA classification type as defined in IESNA HB-9.

b. Shielding as defined by IESNA RP-8 or B.U.G. rating for the installed position as defined by IESNA TM-15

c. Provide safety certification and file number for the luminaire family. Include listing, labeling and identification per NFPA 70 (NEC). Applicable testing bodies are determined by the US Occupational Safety Health Administration (OSHA) as Nationally Recognized Testing Laboratories (NRTL) and include: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratory).

1-4.3 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer. Component parts of the item shall be the products of the same manufacturer, unless stated otherwise in this section.

1-4.3.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable if the manufacturer has been regularly engaged in the design and production of high intensity discharge roadway and area luminaires for a minimum of 15 years. Products shall have been in satisfactory commercial or industrial use for 15 years prior to bid opening. The product shall have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 15-year period.

1-4.3.2 Material and Equipment Manufacturing Date

Products manufactured more than 1 year prior to date of delivery to site shall not be used, unless specified otherwise.

1-4.4 Energy Efficiency

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NOTE: Include bracketed option on Energy Star compliance and identify the specific product (i.e. street lighting or area lighting) when at least two manufacturers meet the requirements in this spec and are energy star compliant for that specific product as well.

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Comply with National Energy Policy Act. [Comply with Energy Star requirements for the following lighting products: [___]].

1-4.5 Warranty

Life of exterior LED lighting (primarily the luminaire) is not yet well understood given the relative newness of the technology for this application. Projected life of LED luminaires is a key component to payback scenarios in project evaluations, therefore it is very important that products perform as anticipated. Since life claims provided by suppliers is typically 50,000 hours or greater and the first cost of exterior LED luminaires may be significant, site Warranty shall assure that the product will perform as claimed in terms of useful life.

The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

Provide a written five year on-site replacement warranty for material, fixture finish, and workmanship. On-site replacement includes transportation, removal, and installation of new products.

- Finish warranty shall include warranty against failure and against substantial deterioration such as blistering, cracking, peeling, chalking, or fading.
- Material warranty shall include:
  - All power supply units (PSUs), including drivers.
  - Replacement when more than 10% of LED sources in any lightbar or subassembly(s) are defective or non-starting.
- Warranty period must begin on date of beneficial occupancy. Contractor shall provide the Contracting Officer signed warranty certificates prior to final payment

PART 2 PRODUCTS

2-1 PRODUCT COORDINATION

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NOTE: Select bracketed sections applicable to project, and coordinated with respective Agency projects (i.e Navy, COE, AirForce).

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Products and materials not considered to be lighting equipment or lighting fixture accessories are specified in[Section 33 71 02.00 20 UNDERGROUND ELECTRICAL DISTRIBUTION,] Section 33 71 01 OVERHEAD TRANSMISSION AND DISTRIBUTION,[Section 33 70 02.00 10

UNDERGROUND TRANSMISSION AND DISTRIBUTION SYSTEM,][and] Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.[Lighting fixtures and accessories mounted on exterior surfaces of buildings are specified in Section 26 51 00 INTERIOR LIGHTING.]

2-2 LUMINAIRES

UL 1598 and UL 8750. Provide luminaires as indicated. Provide luminaires complete with LED light source and power supply unit. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to luminaires of a particular manufacturer. Luminaires of similar designs, light distribution and brightness characteristics, and of equal finish and quality will be acceptable as approved.

2-2.1 General Requirements

a. Luminaire shall be UL-listed for wet locations and wiring cavity must be field accessible for service or repair needs.

b. Luminaire shall be full cutoff or fully shielded as defined by IESNA RP-8. Alternatively, the full cutoff can be validated by meeting the following IESNA TM-15 B-U-G Ratings (backlight, uplight, and glare):

   - maximum uplight (U) rating of U0 for residential areas and U1 for all other areas.
   - maximum glare (G) rating equal to G0 for residential areas and G2 for all other areas.

c. Optical system for roadway and area luminaires shall be sealed and rated for IP 66 as defined in NEMA 60529.

d. Luminaire shall be fully assembled and electrically tested prior to shipment from factory.

e. For all mast arm mounted luminaires, a wildlife shield shall be included in the fixture to prevent wildlife access to the fixture.

f. Color of the luminaire shall be bronze unless specified otherwise.

g. The coating must be capable of surviving ASTM B 117 Salt Fog environment for 1000 hrs minimum without blistering or peeling.

h. The coating shall demonstrate gloss retention of greater than or equal to 90% for 1000 hrs exposure QUV test per ASTM G 154 UVB-313 Lamps, 4 hr Condensation 50 °C.

i. Luminaire shall be tested according to IEC 60068-2-14 for thermal shock. Luminaire shall be fully functional after completion of testing.

j. Luminaire shall be tested according to IEC 60068-2-30, damp heat, steady state, for high humidity and high temperatures. Luminaire shall be fully functional after testing.

k. Luminaire arm bolts shall be 304 stainless steel or zinc plated steel.

l. If a lens not integral to the LED is used, construct the luminaire optical enclosure (lens/window) of clear and UV-resistant acrylic or tempered glass.

m. 80% of the luminaire material by weight should be recyclable at end of life.

n. Produce a minimum efficacy of 60 lumens per Watt driven at 350mA or a minimum of 50 lumens per Watt driven at 525mA tested per IESNA LM-79. Theoretical models of initial raw LED lumens per watt are not acceptable.

o. Incorporate modular electrical connections and construct luminaire to allow replacement of all or any part of the optics, heat sinks, power supply units, and electrical components using only a simple tool, such as a screwdriver.

p. Luminaire shall have a nameplate bearing the manufacturer's name, address, model number, date of manufacture, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

q. Fixture weight and effective projected area (EPA) shall not exceed the pole requirements for wind loading. Provide wind-loading calculations.

r. Roadway and area luminaires shall have an integral tilt adjustment of +/- 5º to allow the unit to be leveled, in accordance with NEMA C136.3.

s. Luminaire must pass 3G vibration testing in accordance with ANSI C136.31.

2-2.2 Wiring

a. All factory electrical connections shall be made using crimp, locking, or latching style connectors. Twist style wire nuts are not acceptable.

2-2.3 Power Supply Units

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NOTE: Normal ambient temperature of 40 degree C (104 degrees F) will be adequate for typical nightime operating environments. Selection of 50 degree C (122 degrees F) will increase the system cost and should only be used when required for a specific project location. Coordinate with [40] [50] bracketed options in other parts of specification as well.

Use a dimmable driver for all applications that may utilize controls (i.e. smart grid, curfew, motion sensing) as part of this project or the future.

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UL 1310. Power Supply Unit (PSU) including drivers shall meet the following requirements:

a. Minimum efficiency of 85%

b. Drive current per LED shall not exceed 525mA ±10%

c. Rated to operate between ambient temperatures of -30°C and [+40°C] [+50°C]

d. Designed to operate on voltage system to which they are connected ranging from 120 V to 277 V nominal.

e. Operating frequency: 50/60 Hz

f. Power Factor (PF): ≥ 0.90

g. Total Harmonic Distortion (THD) current: ≤ 20%

h. FCC Title 47 Section 15, Class B

i. Reduction of Hazardous Substances (RoHS) compliant.

j. Luminaires under a covered structure such as canopies shall be UL listed with a sound rating of "A."

k. [Driver shall be dimmable and compatible with a standard Dimming Control circuit of 0 - 10V]

2-2.4 LED Light Source

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NOTE: Select CCT values and CRI bracketed options based on application. If a design strategy is to blend with traditional lighting systems in the local area pick a CCT in the 4000 – 4500 K range. This temperature is a warmer light source than 6500 K and provides a balance between color temperature, color rendering, and efficacy of the light source. LED chips are manufactured to achieve maximum efficacy related to a specific color temperature and this varies with chip manufacturer and binning.

Select a range of CCT. One manufacturer might have a 4300 K source while another has a 4000 K source. Therefore, it would be appropriate to indicate the 4000 K & 4500 K CCT. Note: high pressure sodium is 2700 K, warm metal halide is 3200 K, clear metal halide is 4000 K, and moon light is 4100 K.

6500 K is a cooler temperature and should only be used when color rendering or environmental concerns such as sky glow are not a factor. Note: objects appear bluish and items in the red color spectrum may appear distorted.

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a. Luminaires must be rated for operation in ambient temperatures of -30°C to [+40°C] [+50°C].

b. Correlated Color Temperature (CCT) shall be in accordance with ANSI C78.377.

[Nominal CCT: 3000 K: 3045 ± 175 K or

Nominal CCT 3500 K: 3465 ± 245 K]

[Nominal CCT: 4000 K: 3985 ± 275 K or

Nominal CCT 4500 K: 4503 ± 243 K]

Nominal CCT 5000 K: 5028 ± 283 K or

Nominal CCT 5700 K: 5665 ± 355]

[Nominal CCT: 6500 K: 6530 ± 510 K]

c. Color Rendering Index (CRI) shall be:

[≥ 80 for 3000 K – 3500 K]

[≥ 70 for 4000 K – 6500 K]

2-3 ELECTRICAL SYSTEM

2-3.1 Surge Protection

Provide surge protection integral to luminaire to meet "C Low" waveforms as defined in IEEE C62.41.2, Scenario 1 Location Category C.

2-4 CONTROLS

2-4.1 Daylighting Controls

All exterior parking lot, drive, and front aisle areas shall be controlled such that exterior luminaires shall not operate during hours of daylight. Controls may include a combination photocell plus timeswitch.or an energy management system. Controls shall allow automatic on and off settings based on daylighting, plus timed off settings after expected activity ends. Energy management system shall have pre-determined control strategies to include automatic dimming for adaptive standards. Dimming controls shall work with a 0-10V dimmable driver.

2-4.2 Photocell Switch

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NOTE: Remove bracketed options that are not applicable to project. Coordinate voltage with fixture specified. Determine if single or double throw contacts will be required, and total load. Provide lens when necessary to prevent inadvertent operation of photocell.

****

UL 773 or UL 773A, hermetically sealed cadmium-sulfide or silicon diode type cell, rated [_____] volts ac, 60 Hz, with[single-throw contacts][single pole double-throw (spdt) contacts for mechanically held contactors rated [1000][1800] watts] designed to fail to the ON position. Switch shall turn on at or below 32 lux (3 footcandles) and off at 43 to 107 lux (4 to 10 footcandles). A time delay shall prevent accidental switching from transient light sources. [Provide a directional lens in front of the cell to prevent fixed light sources from creating a turnoff condition.] Provide switch:

a. Compliant with Reduction of Hazardous Substances (RoHS).
b. Utilizing an ambient light sensing technology which inherently minimizes the contribution of typical high power LED light sources to the sensed light level.
c. With a rated life expectancy of 90,000 hours continuous operation
d. [In a high-impact-resistant, noncorroding and nonconductive molded plastic housing with a [fixture mounted] locking-type receptacle conforming to NEMA C136.10 and rated 1800 VA, minimum.]
e. [In a cast weatherproof aluminum housing with adjustable window slide, rated 1800 VA, minimum.]
f. [In a U.V. stabilized polycarbonate housing with swivel arm and adjustable window slide, rated 1800 VA, minimum.]
g. [Integral to the luminaire, rated 1000 VA, minimum.]

2-4.3 Timeswitch

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NOTE: Provide voltage rating and remove bracketed options that are not applicable to project.

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Astronomic dial type or electronic type, arranged to turn "ON" at sunset, and turn "OFF" at predetermined time between 8:30 p.m. and 2:30 a.m. or sunrise, automatically changing the settings each day in accordance with seasonal changes of sunset and sunrise. Provide switch rated [_____] volts, having automatically wound spring mechanism or capacitor, to maintain accurate time for a minimum of 7 hours following power failure. Provide time switch with a manual on-off bypass switch. Housing for the time switch shall be surface mounted, NEMA [3R][_____] enclosure conforming to NEMA ICS 6.

2-5 [OPTIONAL CONTROLS

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NOTE: The following options are cost adders. Utilizing controls can add significant savings, however must be coordinated with security issues in the area of application.

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2-5.1 [Curfew Control

Provide curfew control. Curfew Control shall include after hours dimming control to reduce light levels to approximately [50%] [___] of full lumen output at a predetermined time. This time setting will normally be after expected activity ends. Design controls to fail to the ON full output position]

2-5.2 [Occupancy Sensor Controls

NEMA WD 7, UL 773A. Provide passive infrared or microwave sensor with 360° coverage, time delay that can be adjusted from 30 seconds to 30 minutes, and designed to fail to the ON position. Sensors shall be located to achieve coverage of areas indicated. Coverage patterns shall be derated as recommended by manufacturer based on mounting height of sensor and any obstructions such as trees. Do not use gross rated coverage in manufacturer's product literature. Sensors integral to the luminaire must be provided by luminaire manufacturer.

a. Infrared: Integral to the luminaire. Shall detect occupancy by changes in infrared energy within a coverage area and shall be capable of operating between -40°C and +50°C.

b. Microwave: Integral to luminaire. Shall detect occupancy by transmitting electromagnetic energy into a coverage area, receiving direct and reflected energy, and monitoring frequency shift between transmitted and received signals. When more than one device is used in an area, devices shall operate on different frequencies. Provide for selective filtering by the sensor to minimize nuisance tripping due to interference from radar, or other sources of electronic interference.]]